

PATENT SPECIFICATION

NO DRAWINGS

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COMPLETE SPECIFICATION

Sintered Hard Metal

WE, WICKMAN WIMET LIMITED, a British Company, of Torrington Avenue, Coventry, Warwickshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The properties of the well known sintered hard metals, also known as "cemented carbides", make them very suitable for use as cutting tools. A useful combination of hardness and toughness results from their structure, which consists of hard but brittle carbide particles bonded together with a softer but tough metal, which is usually cobalt. Cutting tools have to withstand heavy stresses and shock loads and also must resist wear, but for some other uses of hard metals less toughness and greater resistance to wear are required. Moreover if an article made of hard metal is subjected to corrosive action, such as attack by mineral acid, it is desirable to eliminate the metal phase since this is more rapidly attacked by many corrosive media than is the metal carbide.

Numerous attempts have been made in the past to fabricate bodies from carbides alone without any metallic bond. A few carbides, for example tungsten carbide with about 4% carbon, can be melted and cast. Such cast carbide can be utilised for a few purposes but is too inhomogeneous and coarse-grained for many purposes and is very brittle.

It is also possible to sinter the powdered carbide without any metallic bond, but the resultant products are very porous unless the sintering is effected at very high temperature. Very high temperatures are difficult and expensive to achieve and the carbides sintered at such high temperatures are coarse in structure and brittle.

[Price 4s. 6d.]

Another method is to use a fugitive binder, that is to say a small amount of metallic binder which is mixed with the carbide and greatly accelerates the sintering process; the article is sintered and subsequently heated for a prolonged period to a very high temperature in vacuum to remove the binder metal by volatilisation. This method is also expensive and the product is coarse in structure and brittle.

According to the invention an article having a tough body and a wear-resistant surface is formed by sintering a compact of two powders of different composition. One of these powders has the composition of the body, that is to say it comprises carbide and a binder metal, at least 80% of the carbide being tungsten carbide and the remainder (if any) being tantalum carbide, titanium carbide or carbide of other metal of the 4th and 5th groups of the Periodic Table. The second powder, which is applied as a thin layer on top of the first and subsequently provides the wear-resistant surface, comprises a mixture of carbide and binder metal, all or the major part of the carbide in this mixture being tantalum carbide, titanium carbide or carbide of other metal of the 4th and 5th Groups of the Periodic Table. We find that when the composite compact is sintered, the binder metal migrates from the thin layer into the body. The extent to which this migration takes place depends largely on the proportion of carbide of metal of the 4th and 5th groups of the Periodic Table in the thin layer, and to some extent on the relative proportions of the binder metal in the layer and body respectively. If the layer consists only of such carbide and binder metal or contains a very high proportion of such carbide, substantially all of the binder metal drains from the layer, leaving it consisting

almost entirely of carbides.

The carbides most frequently used in the preparation of hard metal articles are those of tungsten, titanium or tantalum. A satisfactory hard metal article can be produced according to the invention by forming the body of the article from a mixture of tungsten carbide and cobalt and the surface layer from a mixture composed predominantly of titanium or tantalum carbide or both, a minor amount of tungsten carbide and cobalt as a binder.

The binder metal is usually cobalt but may be nickel or iron. For ease of description the invention will be further described with reference to cobalt only.

In producing hard metal by sintering, the duration of the sintering is from $\frac{1}{2}$ to 2 hours, normally being about 1 hour. We find that maximum migration normally takes place within the ordinary period of sintering, but that if the layer is porous, as it tends to be, it may be advantageous to increase the period of sintering in order largely to eliminate this porosity.

The resultant product comprises a layer of carbide almost free from metallic binder on the surface of a body consisting essentially of hard metal carbide bonded with a metal of the iron group. It is of little use as a cutting tool, but can be used with great advantage as any article or part which requires considerable resistance to wear, for instance as a wear-resistant plate.

Products made by means of the invention have very low wear rate, high resistance to oxidation and corrosion, and higher strength of the sintered compact as a whole than can be achieved in a product consisting entirely of the carbide without metallic bond. Moreover the products are more easily fabricated than sintered compacts consisting entirely of carbide without metallic bond.

As an example, two batches of powder were made. One containing 6% cobalt and 94% tungsten carbide by weight, and the other 9% cobalt, 82% tantalum carbide and 9% tungsten carbide by weight. A small rectangular compact was pressed in a die from the first of these powders at a pressure of 1 ton per square inch. A thin layer of the second powder was placed on top, and the whole was repressed at 5 tons per square inch. After sintering in a vacuum furnace at 1440°C for one hour, the composite body was found to consist of a thick base of tungsten carbide and cobalt and a surface layer

consisting almost entirely of tantalum carbide containing in solid solution about 10% tungsten carbide.

Examination of the product showed only a few isolated areas of cobalt in the surface layer, which was almost free from porosity.

WHAT WE CLAIM IS:—

1. A process of forming a hard metal article having a tough body and a wear-resistant surface in which a compact of two powders of different composition is made, one powder forming the body of the article and being a mixture of carbide and a binder metal, at least 80% of the carbide being tungsten carbide and the remainder (if any) being tantalum carbide, titanium carbide or other carbide of metals of the 4th and 5th Groups of the Periodic Table, and the other powder forming a surface layer of the compact and being a mixture of carbide and a binder metal, all or the major part of the carbide in this mixture being tantalum carbide, titanium carbide or carbide of other metal of the 4th and 5th Groups of the Periodic Table, and the compact is sintered to unite the two powders and to cause migration of the binder metal from the surface layer into the body.

2. A process of forming a hard metal article having a tough body and a wear-resistant surface in which a compact of two powders of different composition is made, one powder forming the body of the article and being a mixture of tungsten carbide and cobalt and the other powder forming a surface layer of the compact and being a mixture composed predominantly of titanium or tantalum carbide or both, a minor amount of tungsten carbide and cobalt as a binder, and the compact is sintered for long enough both to unite the two powders and to render the surface layer substantially free from binder metal.

3. A process according to claim 1 or claim 2 in which the sintering is carried on for long enough to eliminate porosity in the surface layer.

4. A process according to claim 1 or claim 2 substantially as described with reference to the example herein.

5. A hard metal article made by a process according to any one of claims 1 to 4.

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